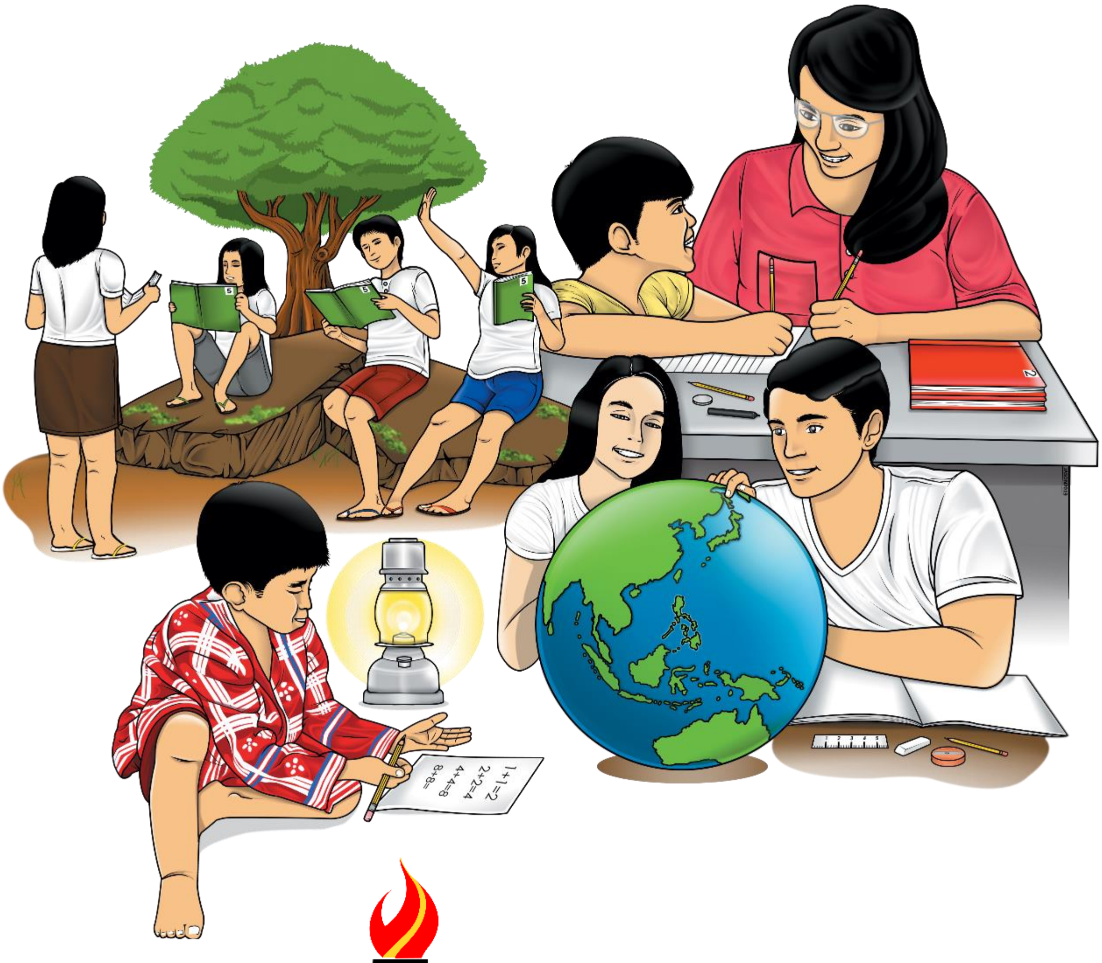
Senior High School

Physical Science

Quarter 1 – Module 10: Limiting Reactants and the Amount of Products Formed



ALTERNATIVE DELIVERY MODE

Personal Development
Alternative Delivery Mode
Quarter 1 – Module 10: Limiting Reactants and the Amount of Products Formed
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Quarter 1 – Module 10:
Limiting Reactants and the Amount of Products Formed

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Introductory Message

For the facilitator:

Welcome to the Physical Science Grade 11 Alternative Delivery Mode (ADM) Module on Limiting Reactants and the Amount of Products Formed!

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21^{st} century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the Physical Science Grade 11 Alternative Delivery Mode (ADM) Module on Limiting Reactants and the Amount of Products Formed!

The hand is one of the most symbolized part of the human body. It is often used to depict skill, action and purpose. Through our hands we may learn, create and accomplish. Hence, the hand in this learning resource signifies that you as a learner is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:

What I Need to Know	This will give you an idea of the skills or competencies you are expected to learn in the module.
What I Know	This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.
What's In	This is a brief drill or review to help you link the current lesson with the previous one.
What's New	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.
What is It	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
What's More	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
What I Have Learned	This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.
What I Can Do	This section provides an activity which will help you transfer your new knowledge or

skill into real life situations or concerns.

Assessment — This is a task which aims to evaluate your level of mastery in achieving the learning competency.

Additional Activities — In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.

Answer Key — This contains answers to all activities in the module.

At the end of this module you will also find:

References — This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don’t forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

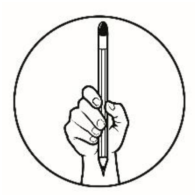
We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

What I Need to Know

This module was designed and written with you in mind. It is here to help you to use the stoichiometric calculation to determine excess and limiting reactants in a chemical reaction. Also, it helps you to understand on how to perform calculation in product formation. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

After going through this module, you are expected to:

1. recall the meaning of chemical reactions, products and reactants;
2. review how to balance equations of chemical reactions;
3. recall the possible conversions in chemical reactions;
4. analyze a chemical reaction in order to determine which reactant is the limiting reactant and which is the excess reactant;
5. calculate the theoretical yield of a reaction when the available amounts of each reactant are known; and
6. calculate the percent yield of a reaction based on the theoretical and actual yields.



What I Know

Directions: Read and answer each question below.

1. In the equation Mg + $O_2(g) \rightarrow$ MgO, how many molecules of Mg on the reactant side do we need to make our equation balance?
   a. 1 c. 3
   b. 2 d. 4

2. Use the following BALANCED equation: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
   If 15 g of C_2H_6 react with 45 g of O_2, how many grams of water will be produced?
   a. 22 g H_2O c. 27 g H_2O
   b. 23 g H_2O d. 28 g H_2O

3. What is the limiting reactant in the equation in item number 2?
   a. O_2 c. H_2O
   b. C_2H_6 d. CO_2

4. What is the excess reactant in the equation in item number 2?
   a. O_2 c. H_2O
   b. C_2H_6 d. CO_2

5. Consider the following reaction: $2Al + 6HBr \rightarrow 2AlBr_3 + 3H_2$
   When 86.9 grams of Al reacts with 401 grams of HBr, how many H_2 are formed?
   a. 5.01 g c. 8.01 g
   b. 7.01 g d. 10.01 g

6. What is the limiting reactant in item no. 6?
   a. Al c. HBr
   b. $AlBr_3$ d. H_2

7. For the excess reactants, how many grams are left over at the end of the reaction?
   a. 42.3 g c. 47.4 g
   b. 44.3 g d. 48.4 g

8. It is reactants that are not used up when the reaction is finished.
   a. reactants b. limiting reagents
   b. solute d. excess reagents

9. It deals with the process that involves rearrangement of the molecular or ionic structure of a substance to form a new substance or product.
   a. chemical equilibrium
   b. chemical symbol
   c. chemical reaction
   d. stoichiometry

10. Which of the following is the correct sequence of a chemical equation?
   a. Reactant → Product
   b. Product → Reactant
   c. Reactant + Product
   d. Product + Reactant

11. Write the equation for the reaction of iron (III) phosphate with sodium sulfate to make iron (III) sulfate and sodium sulfate.

12. If I perform this reaction with 25 grams of iron (III) phosphate and an excess of sodium sulfate, how many grams of iron (III) phosphate can I make?

13. If 18.5 grams of iron (III) phosphate are actually made when I do this reaction, what is my percent yield?

14. Is the answer from problem #3 reasonable? Explain.

15. If I do this reaction with 15 grams of sodium sulfate and get a 65.0% yield, how many grams of sodium phosphate will I make?

Lesson 1 Physical Sciences: Limiting Reactants and the Amount of Products Formed

Chemical equations give the ideal stoichiometric relationship among reactants and products. However, sometimes the amount of reactants used are not mixed in exact or proper ratio. Thus, there are instances that some reactant will be excess and the others will be completely used up. In a chemical reaction, reactants that are not used up when the reaction is finished are called excess reagents. The reagent that is completely used up or reacted is called the limiting reagent, because its quantity limits the amount of products formed.

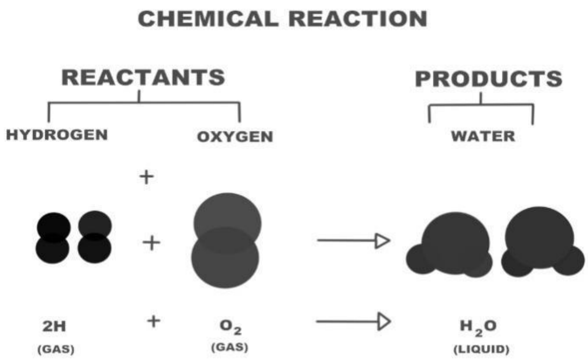


Fig 1

Figure shows the parts of chemical reaction. We have two elements in the reactant side that will undergo chemical reaction to produce a product: A + B → AB. An example of a synthesis reaction is the combination of two molecules of H and two molecules of Oxygen gas to produce one molecule of water.

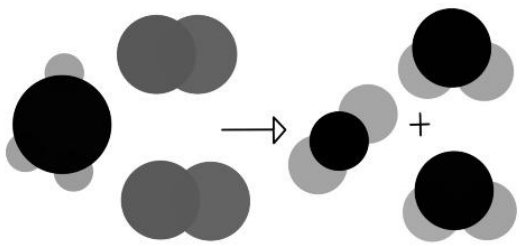
What's In

Chemical reaction deals with the process that involves rearrangement of the molecular or ionic structure of a substance, as opposed to a change in physical form or a nuclear reaction.

A chemical equation shows the starting compound(s)—the reactants—on the left and the final compound(s)—the products—on the right, separated by an arrow. In a balanced chemical equation, the numbers of atoms of each element and the total charge are the same on both sides of the equation.

For example:

The figure shows the combustion of hydrocarbons like CH_4 (methane) will produce carbon dioxide and water.



$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. You are also tasked to review them on the fundamentals of balancing chemical equation. Furthermore, you need to explain the importance of reactants and reagents in solving different problems involving stoichiometry.

What's New

Key Terms

- **Stoichiometry** is a section of chemistry that involves using relationships between reactants and/or products in a chemical reaction to determine desired quantitative data.
- **Excess reagent** is a reactant that is not used up when the reaction is finished.
- **Limiting reagent** is a reagent that is completely used up or reacted.

Activity 1: Sweet Balance

In this activity, you will be introduced to simple stoichiometry. *Stoichiometry* is the chemical term to describe calculations that allow us to find the amounts of chemicals involved in each reaction.

In stoichiometry, you must always start with a balanced equation. We will use the following balanced material (equation):

$$2\ EG + 1\ EP \rightarrow 1\ ToTa$$

Where: EG= egg
EP = eggplant
ToTa= Tortang Talong

1. Notice that to make this recipe you have three pieces (reactant) to the left of the arrow and one piece (product) to the right. This is supposed to represent a balanced equation, so how can 3 = 1?

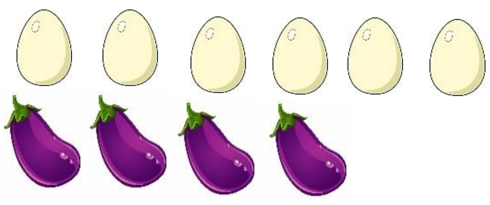
It's because the pieces combine to form one whole. This would represent a synthesis reaction.

2. If each student is to make one Tortang Talong, and I have 20 students, how much of each ingredient will I need? Explain your logic – using a chemical equation.

$2\ EG + 1\ EP \rightarrow 1\ ToTa$ (Use the ratio of the coefficients)

40 20 20

Let's look at a simplified view of the Tortang Talong example. She starts out with six Eggs and four Eggplant.



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3

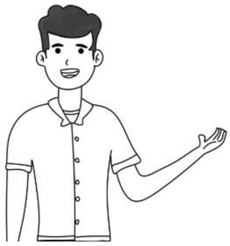
9

How many eggplants would be needed if all six of the eggs were used?

Which of the two ingredients do you think will be used up first?

Which ingredient will have excess?

Let’s ask Professor F:



Hi there, let me help you!

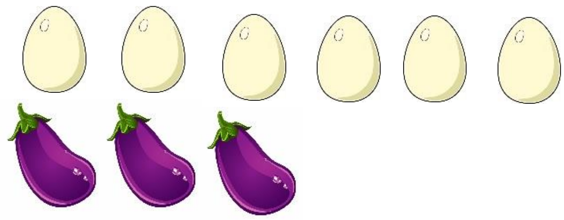
The correct answer is THREE. WHY?

The six eggs would require three eggplant to make three Tortang Talong.

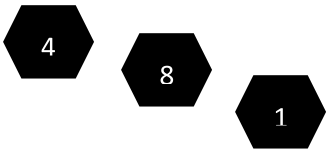
Which of the two ingredients run out first? Answer: Egg

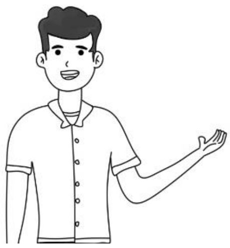
Since she has four eggplant (a greater supply than what is needed), the egg will limit the number of Tortang Talong she can make.

Alternatively, you could look at the number of eggs that would be needed.



Suppose wanted to make Tortang Talong using the available ingredients earlier, how many graham crackers would I need if I have four Eggplant?





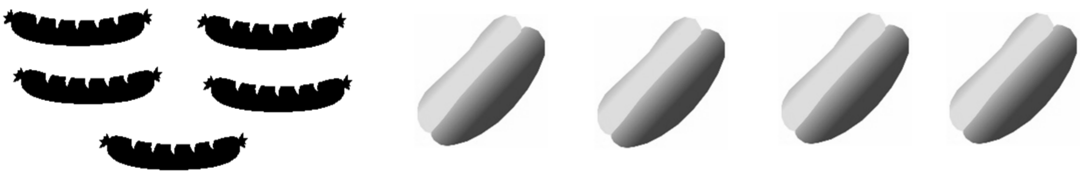
Great, the four eggplant would require eight eggs to make four Tortang Talong.

Since there are only six eggs (a supply less than what is needed), the eggs will limit the number of tortang talong she can make.

You can see that the conclusion reached was the same regardless of the ingredient (or reactant) chosen.

Let’s Try This!

We have five hot dogs and four hot dog buns. How many complete hot dogs can we make?



What is It

PROBLEM SOLVING TIP:

The first and most important step for any stoichiometric calculation—such as finding the limiting reagent or theoretical yield—is to start with a balanced reaction. Since our calculations use ratios based on the stoichiometric coefficients, our answers will be incorrect if the stoichiometric coefficients are not right.

Here are the steps on how to balance a chemical equation:

Step 1: Count the number of atoms of each element in the reactants and the products. List each element and how many atoms are there in the reactants and products side.

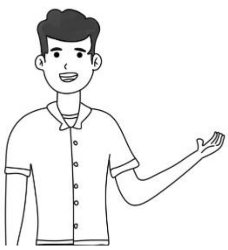
Example:

$$HCl + Na_2S \rightarrow H_2S + NaCl$$

Reactant		Product	
H	1	H	2
Cl	1	Cl	1
Na	2	Na	1
S	1	S	1

Step 2:

1.

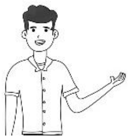


Example 1: Finding the limiting reagent

For the following reaction, what is the limiting reagent if we start with 2.80g of Al (Aluminum) and 4.25g of Cl (Chlorine)?

$$2Al + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$$

First, let's check if our reaction is balanced: we have two Al atoms and six Cl atoms on both sides of the arrow, so we are good to go! In this problem, we know the mass of both reactants, and we would like to know which one will get used up first. In the first step, we will convert everything to moles, and then we will use the stoichiometric ratio from the balanced reaction to find the limiting reagent.



Step 1: Convert amounts (grams) to moles.

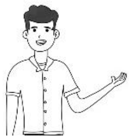
We can convert the masses of Al and Cl_2 to moles using molecular weights:

$$\text{moles of Al} = 2.80\,\cancel{\text{g Al}} \times \frac{1\,\text{mol Al}}{26.98\,\cancel{\text{g Al}}} = 1.04 \times 10^{-1}\,\text{mol Al}$$

(Convert g Al to mol Al)

$$\text{moles of } \text{Cl}_2 = 4.25\,\cancel{\text{g Cl}_2} \times \frac{1\,\text{mol Cl}_2}{70.90\,\cancel{\text{g Cl}_2}} = 5.99 \times 10^{-2}\,\text{mol Cl}_2$$

(Convert g $Cl_2$to mol Cl_2)



Step 2: Find the limiting reagent using the stoichiometric ratio.

Now that our known quantities are in moles, there are multiple ways to find the limiting reagent. We will show three methods here. They all give the same answer, so you can choose your favorite. All three methods use the stoichiometric ratio in slightly different ways.

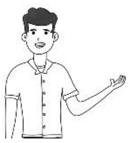
METHOD 1: The first method is to calculate the actual molar ratio of the reactants, and then compare the actual ratio to the stoichiometric ratio from the balanced reaction.

$$\text{Actual ratio} = \frac{\text{moles of Al}}{\text{moles of Cl}_2} = \frac{1.04 \times 10^{-1}\,\text{mol Al}}{5.99 \times 10^{-2}\,\text{mol Cl}_2} = \frac{1.74\,\text{mol Al}}{1\,\text{mol Cl}_2}$$

The actual ratio tells us that we have 1.74 mol of Al for every 1 mol of Cl_2. In comparison, the stoichiometric ratio from our balanced reaction is below:

$$\text{Stoichiometric ratio} = \frac{2\,\text{mol Al}}{3\,\text{mol Cl}_2} = \frac{0.67\,\text{mol Al}}{1\,\text{mol Cl}_2}$$

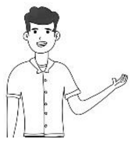
This means we need at least 0.67 moles of Al for every mole of Cl_2. Since our actual ratio is greater than our stoichiometric ratio, we have more Al than we need to react with each mole of Cl_2. Therefore, $Cl_2$is our limiting reagent and Al is in excess.



METHOD 2: A more guess-and-check way you can figure out the limiting reactant is by picking one of the reactants—it doesn't matter which one—and pretending that it is the limiting reagent. We can then calculate the moles of the other reagent needed based on the moles of our pretend limiting reagent. For example, if we pretend that Al is the limiting reagent, we would calculate the required amount of Cl_2 as follows:

$$\text{moles of Cl}_2 = 1.04 \times 10^{-1}\,\cancel{\text{mol Al}} \times \frac{3\,\text{mol Cl}_2}{2\,\cancel{\text{mol Al}}} = 1.56 \times 10^{-1}\,\text{mol Cl}_2$$

Based on this calculation, we would need 1.56×10^{-1} mol of Cl_2 if Al is actually the limiting reagent. Since we have 5.99×10^{-2} mol Cl_2 which is less than 1.56×10^{-1} mol of Cl_2 our calculation tells us that we would run out of Cl_2 before we fully reacted all of the Al. Therefore, 1.56×10^{-1} mol of Cl_2 is our limiting reagent.



METHOD 3: The third method uses the concept of a mole of reaction, which is abbreviated as *mol-rxn*. *One mole of reaction* is defined as occurring when the number of moles given by the coefficients in your balanced equation react. That definition can sound rather confusing, but the idea is hopefully more clear in the context of our example. In the current reaction, we would say that one mole of reaction is when two moles of Al react with three moles Cl_2 to produce two moles $AlCl_3$ which we can also write as:

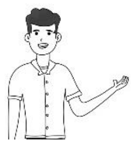
$$1\text{mol-rxn} = 2\text{mol Al} = 3\text{mol } Cl_2 = 2\text{mol } AlCl_3$$

We can use the above relationship to set up ratios to convert the moles of each reactant to moles of reaction:

$$1.04 \times 10^{-1} \cancel{\text{mol Al}} \times \frac{1\,\text{mol-rxn}}{2\,\cancel{\text{mol Al}}} = 5.20 \times 10^{-2}\,\text{mol-rxn} \qquad \text{(Convert mol Al to mol-rxn)}$$

$$5.99 \times 10^{-2} \cancel{\text{mol Cl}_2} \times \frac{1\,\text{mol-rxn}}{3\,\cancel{\text{mol Cl}_2}} = 2.00 \times 10^{-2}\,\text{mol-rxn} \qquad \text{(Convert mol Cl}_2\text{ to mol-rxn)}$$

The more moles of reaction you have, the more times the reaction can occur. Therefore, the reactant with fewer moles of reaction is the limiting reagent since the reaction can be carried out fewer times with that reactant. We see that this method also Cl2 is our limiting reagent because it makes 2.00×10^{-2}mol-rxn, which is less than 5.20×10^{-2}mol-rxn, from Al.



Example 2: Calculating theoretical yield

Now that we know the limiting reagent, we can use that information to answer the following question:

What is the theoretical yield of $AlCl_3$ that the reaction can produce when we start with 4.25 g of Cl_2, our limiting reagent?

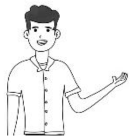
We can use the moles of limiting reagent plus the stoichiometric ratios from our balanced reaction to calculate the theoretical yield. The coefficients from the

$$\text{Theoretical yield in moles} = 5.99 \times 10^{-2} \cancel{\text{mol Cl}_2} \times \frac{2\,\text{mol AlCl}_3}{3\,\cancel{\text{mol Cl}_2}} = 3.99 \times 10^{-2}\,\text{mol AlCl}_3$$

balanced reaction tell us that for every three mol of Cl_2 we should make two mol of $AlCl_3$. Therefore, the theoretical yield, in moles, is:

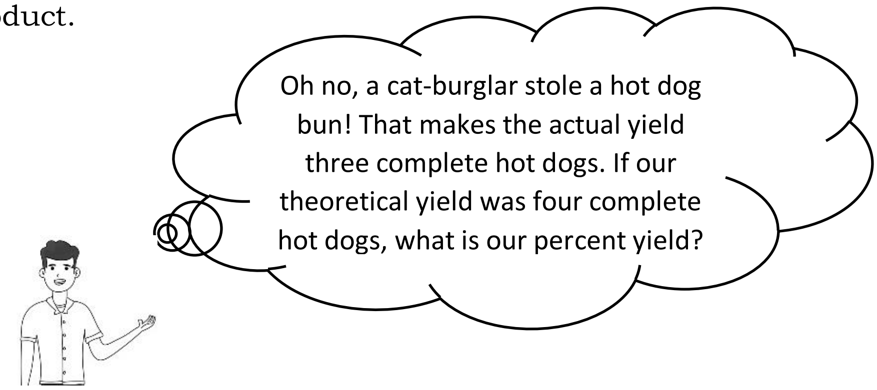
The theoretical yield is usually expected to have units of mass, so we can convert moles of $AlCl_3$ to grams using the molecular weight:

$$\text{Theoretical yield in grams} = 3.99 \times 10^{-2}\,\cancel{\text{mol AlCl}_3} \times \frac{133.33\text{ g AlCl}_3}{1\,\cancel{\text{mol AlCl}_3}} = 5.32\text{ g AlCl}_3$$

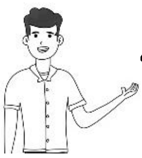


Percent Yield

The theoretical yield is the maximum amount of product you would expect from a reaction based on the amount of limiting reagent. In practice, however, chemists don't always obtain the maximum yield for many reasons. When running a reaction in the lab, loss of product often occurs during purification or isolation steps. You might even decide it is worth losing 10% of your product during an extra purification step because it is more important to have extremely pure product—as opposed to having a larger amount of less pure product.



Source: https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/limiting-reagent-stoichiometry/a/limiting-reagents-and-percent-yield



Despite how nice and tidy a balanced reaction appears, reactants can also react in unexpected and undesirable ways such as doing an entirely different reaction—sometimes called a *side reaction*—to give products that we don't want. Your actual yield may change based on factors such as the relative stability of reactants and products, the purity of the chemicals used, or the humidity on a given day. In some cases, you might be left with all starting materials and no products after your reaction. The possibilities are endless!

Since chemists know that the actual yield might be less than the theoretical yield, we report the actual yield using percent yield, which tells us what percentage of the theoretical yield we obtained. This ratio can be very valuable to other people who

$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

might try your reaction. The percent yield is determined using the following equation:

Since percent yield is a percentage, you would normally expect to have a percent yield between zero and 100. If your percent yield is **greater than 100**, that probably means you **calculated or measured something incorrectly**.

Example 3. Calculating theoretical and percent yield

For example, the decomposition of magnesium carbonate ($MgCO_3$) forms 15 grams of magnesium oxide (MgO) in an experiment. The theoretical yield is known to be 19 grams. What is the percent yield of magnesium oxide (MgO)?

$MgCO_3$	**MgO**	**CO_2**
Mg =1x24.31 g/mol C = 1x12.01 g/mol O=3x16.00 g/mol	Mg =1x24.31 g/mol O=1x16.00 g/mol	C = 1x12.01 g/mol O=2x16.00 g/mol
$MgCO_3$=84.32 g/mol	MgO = 40.31 g/mol	CO_2=44.01 g/mol

$$MgCO_3 \rightarrow MgO + CO_2$$

What is the percent yield of the reaction?

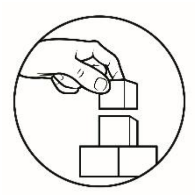
First, we check to see if the reaction is balanced. It looks like we have equal numbers of all atoms on both sides, so now we can move on to calculating the theoretical yield.

The calculation is simple if you know the actual and theoretical yields. All you need is substitute the values into the formula:

percent yield = 15 g / 19 g x 100%

percent yield = 79%

Usually, you have to calculate the theoretical yield based on the balanced equation. In this equation, the reactant and the product have a 1:1 mole ratio, so if you know the amount of reactant, you know the theoretical yield is the same value in moles (not grams!). You take the number of grams of reactant you have, convert it to moles, and then use this number of moles to find out how many grams of product to expect.



What's More

Activity 1. Limiting Reactants Calculation

Directions: Answer the following questions below. Use three significant figures in your computation and final answer.

1. Consider the following reaction:

$$2Al + 6Hbr \rightarrow 2\ AlBr_3 + 3H_2$$

   a. When 3.22 moles of Al react with 4.96 moles of HBr, how many moles of H_2 are formed?
   b. What is the limiting reactant?

2. Consider the following reaction:

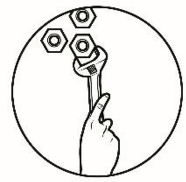
$$3Si + 2N_2 \rightarrow Si_3N_4$$

   a. When 21.44 moles of Si react with 17.62 moles of N_2, how many moles of Si_3N_4 are formed?
   b. What is the limiting reactant?

What I Have Learned

Directions: Read the statement below carefully and fill in the blank(s) with the correct answer.

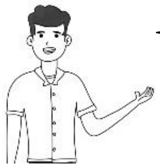
1. The ____________________ is the reactant that gets used up first during the reaction and also determines how much product can be made.
2. ________________ is a section of chemistry that involves using relationships between reactants and/or products in a chemical reaction to determine desired quantitative data.
3. ________________ is a reactant that is not used up when the reaction is finished.
4. ________________ is a reagent that is completely used up or reacted.



What I Can Do

Activity 2: Limiting Reactants Activity

Do the activity below using your knowledge about limiting reactant.



One (Gu) Guava reacts with four (Je) Jelly to form a (GuJe) Guava Jelly according to the following BALANCED equation.

$$1\ Gu + 4\ Je \rightarrow 1\ GuJe$$

Question No. 1

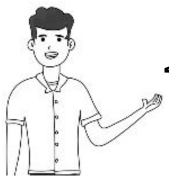
a. How many Guava Jelly (GuJe) can be formed using 5 Guava and 23 Jelly?

b. What is the limiting reactant?

c. What is the excess reactant?

d. How much is left over?

e. Use the balanced equation to answer the following question. One Guava has a mass of 2.0 grams and one Jelly has a mass of 1.5 g. How many Guava Jelly can be made with 12.5 grams of Guava and 15.0 grams of Jelly?



Two PANSIT reacts with six SILING LABUYO to form a HOT Pansit according to the following BALANCED equation.

$$2P + 6\ SB \bullet 1\ HP$$

Question No. 2

a. How many Hot Pansit can be formed using 10 Pansit and 24 Siling Labuyo?

b. What is the limiting reactant?

c. What is the excess reactant?

d. How much is left over?

e. Use the balanced equation to answer the following question. One Pansit has a mass of 5.0 grams and one Siling Labuyo has a mass of 1.0 gram. How many Hot Pansit can be made from 40.0 grams of Pansit and 26.0 grams of Siling Labuyo?

Assessment

Directions: Answer the following questions below on a separate sheet of paper.

1. It is the reactant that produces a lesser amount of product.
   a. Excess Reactant c. Limiting Reactant
   b. Percent Yield d. Co-Factor

2. What is the calculation of the relationship of reactant and product in chemical equation.
   a. Molality c. Balancing Equation
   b. Stoichiometry d. Percent Yield

3. It is the maximum amount of product you would expect from a reaction based on the amount of limiting reagent
   a. Theoretical yield c. Excess Reactant
   b. Limiting Reactant d. Product Difference

4. They are the reactants that are not used up when the reaction is finished.
   a. Excess Reagents b. Limiting Reagents
   b. Solute d. Solution

5. It deals with the process that involves rearrangement of the molecular or ionic structure of a substance to form a new substance or product.
   a. Chemical Equilibrium c. Chemical Symbols
   b. Chemical Reaction d. Stoichiometry

6. What is the expected value for percent yield?
   a. -1 b. 0-100 c. above 100 d. Unknown

7. Which of the following equation below is balanced?
   a. $Al+3O_2 \rightarrow 2Al_2O_3$
   b. $4Al+O_2 \rightarrow 2Al_2O_3$
   c. $4Al+3O_2 \rightarrow Al_2O_3$
   d. $4Al+3O_2 \rightarrow 2Al_2O_3$

8. In the equation $Mg+HCl \rightarrow MgCl_2+H_2$, how many molecules of hydrogen do we need to make hydrogen balanced?
   a. 3 b. 6 c. 2 d. 7
9. What is the proper sequence of a chemical equation?
10. Will 28.7 grams of SiO_2 react completely with 22.6 grams of H_2F_2? If not, identify the limiting reagent. $SiO_2+2H_2F_2 \rightarrow SiF_4+2H_2O$

$$SiO_2 + 2H_2F_2 \rightarrow SiF_4 + 2H_2O$$

Si=20.09 g/mole O= 16.00 g/mole

H= 1.01 g/mole F= 19.00 g/mole

11. What is the limiting reactant in the equation in number 9?
12. What is the excess reactant in the equation in number 10?
13. How many moles of chlorine gas can be produced if 4 moles of $FeCl_3$ react with 4 moles of O_2?

$$FeCl_3 + O_2 \rightarrow Fe_2O_3 + Cl_2$$

14. What is the limiting reactant in the equation in number 13?
15. What is the excess reactant in the equation in number 13?

Additional Activities

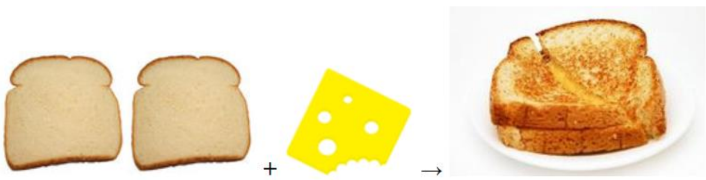
Activity No 3: Make a Sandwich

Scenario: I want to have friends over for lunch on Saturday and make cheese sandwiches that require two slices of bread and one slice of cheese. I open the refrigerator to find that I have 40 slices of cheese. I look in the bread box to find that I have 16 slices of bread.

Question 1: Which of my ingredients is the limiting the number of sandwiches I can make?

Question 2: How many sandwiches can I make?

Question 3: How much of my starting material is left over once I am done making sandwiches?



2 slices of bread + 1 slice of cheese → 1 cheese sandwich

Answer Key

What I Know

1. b
2. a
3. a
4. b
5. a
6. c
7. a
8. d
9. c
10. a
11. 2 FePO4 + 3Na2SO4 → 1 Fe2(SO4)3 + 2Na3PO4
12. 33 grams
13. (18.5/33) x 100% = 56%
14. Yes. Any yield under 100% is reasonable under the law of conservation of mass.
15. According to the stoichiometry, the theoretical yield is 11.5 grams. Multiplying this by 0.650, you get 7.48 grams.

What I Can Do

1
a. 5
b. Guava
c. Jelly
d. 3
e. 2 Guava Jelly

2
a. 4
b. SilingLabuyo
c. Pansit
d. 2
e. 4 Hot Pansit

What's More

1
1. Al= 4.83 mol H_2
   HBr= 2.48 mol H_2
2. HBr

2
a. Si= 7.15 mol Si_3N_4
   N_2= 8.81 mol Si_3N_4
b. Si

Assessment

Answer
1. c 2. b 3. a 4. a
5. b 6. b 7. d 8. c
9-12

$$\text{A. } 28.7\text{ g} \times \frac{1\text{ mole}}{60.08\text{ g}} = 0.478\text{ moles of } SiO_2$$

$$22.6\text{ g} \times \frac{1\text{ mole}}{39.8\text{ g}} = 0.568\text{ moles of } H_2F_2$$

There must be one mole of SiO2 for every two moles of H2F2 consumed. Because the ratio is 0.478 to 0.568, 28.7 grams of SiO2 do not react with the H2F2.
C. Assuming that all of the silicon dioxide is used up, 0.478×21 or 0.956 moles of H2F2 are required. Because there are only 0.568 moles of H2F2, it is the limiting reagent.
13-15. a. six moles of Cl_2
b. $FeCl_3$ c. O_2

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